REMARKS

Status of case

Claims 1-23 are currently pending in this case.

Rejection under 35 U.S.C. §112

Claims 12 and 13 were rejected under 35 U.S.C. §112, second paragraph as being indefinite. Applicants have amended the claims where believed appropriate to overcome the rejection.

Rejection under 35 U.S.C. §103

Claims 5, 9, 10, 11, and 12 were rejected 35 U.S.C. §103(a) as being unpatentable over Shoji (U.S. Patent No. 4,604,006) in view of Aoshima et al. (U.S. Patent No. 4,473,329). The Office Action states that there is no teaching in Shoji of "waiting at least a predetermined time after determination" to supply the current from the power supply to the motor after the load had exceeded a preset reference value. The Office Action states that the Aoshima reference teaches in col. 1, lines 32-54, a drill, after reaching the preset reference value (overload condition), waiting a predetermined period before the drill is advanced again so as to resume cutting of the workpiece. The Office therefore concludes that the claims are obvious in view of the combination. The following is the section of the Aoshima reference that is relied upon by the Office Action:

> Comparing of this reference value (Is) with a load current (I) of a motor which is detected in the course of a cutting is executed in a comparing circuit or comparator, so that the drill in advancing movement may be instantly returned backwards as soon as the load current (I) reaches the reference value (Is), that is when a cutting torque of the maximum allowable limit is applied on the drill. When a certain predetermined period of time has elapsed after the motor was placed under a non-load condition due to the return of the drill, the then non-load current value is memorized in the memory circuit in place of the previous minimum value as a new minimum value (Io). The drill is advanced again so as to resume the cutting of a workpiece which has been halfway suspended. The then load current value (I) of the motor is compared in the comparator with the reference value (Is). When the drill receives a cutting torque of the maximum allowable limit again it is instantly returned backwards similarly to the previous instance. This type of operation is repeated until a bore of a predetermined depth is formed in the workpiece, so that the drill may be prevented from damage or breakage.

Applicants note that the Aoshima reference does not teach several aspects of the limitation as

claimed including: (1) cutting off current to the drill (rather, Aoshima teaches "halfway suspend[ing]" of cutting of a workpiece); (2) waiting a predetermined time after determining that the load current is smaller than a reference value (rather, Aoshima teaches operating for a "certain predetermined time" after the current reaches the reference value (Is)); and (3) preventing an operator from manually turning on the switching element.

First, Aoshima teaches that the current is merely reduced. Specifically, the Aoshima reference teaches operating a drill until an allowable limit (Is) is reached. Once the limit is reaching, the drill is put in a "non-load position." In particular, the motor is "placed under a non-load condition due to the return of the drill" for "a certain predetermined period". After this period, "the then non-load current value is memorized in the memory circuit in place of the previous minimum value (Io)" and the "drill is advanced again so as to resume the cutting of a workpiece **which has been halfway suspended**." Emphasis added. Thus, the Aoshima reference does not teach cutting off the motor, but simply reducing it. This is further supported by the following paragraph in the Aoshima reference, which states:

> The cutting process is however finished in general within 1-3 minutes after a workpiece is placed on the drilling machine, and the motor is stopped between the finish of cutting on one workpiece and the beginning of cutting on another workpiece. In other words, the cutting is carried out in the prior art while the motor (in this instance AC motor is used, but DC motor is also permissible) is under an unstable status, as shown in FIG. 1, wherein the winding current gradually decreases from a large initial current value to a stable current value. It means that the aforesaid minimum value (Io) is set while the winding current is unstable in the course of falling as shown in FIG. 2 and the reference value (Is), on which the cutting process depends, is set according to this minimum value (Io). Comparison of the minimum value (Io) with a current value (Io1), which would have been attained if the minimum value had been set when the winding current reached the reference value (Is), will show that the current value (Io1) is smaller than the minimum value (Io) by an amount of ($\Delta I\alpha$).

Col. 1, line 55 – col. 2, line 7. As shown in the above-excerpt, the "motor is stopped between the finish of cutting on one workpiece and the beginning of another workpiece." The current is not cut-off to the motor when cutting on a workpiece, only reduced, as shown in the current diagram of Figure 1 of the Aoshima reference, reproduced below:

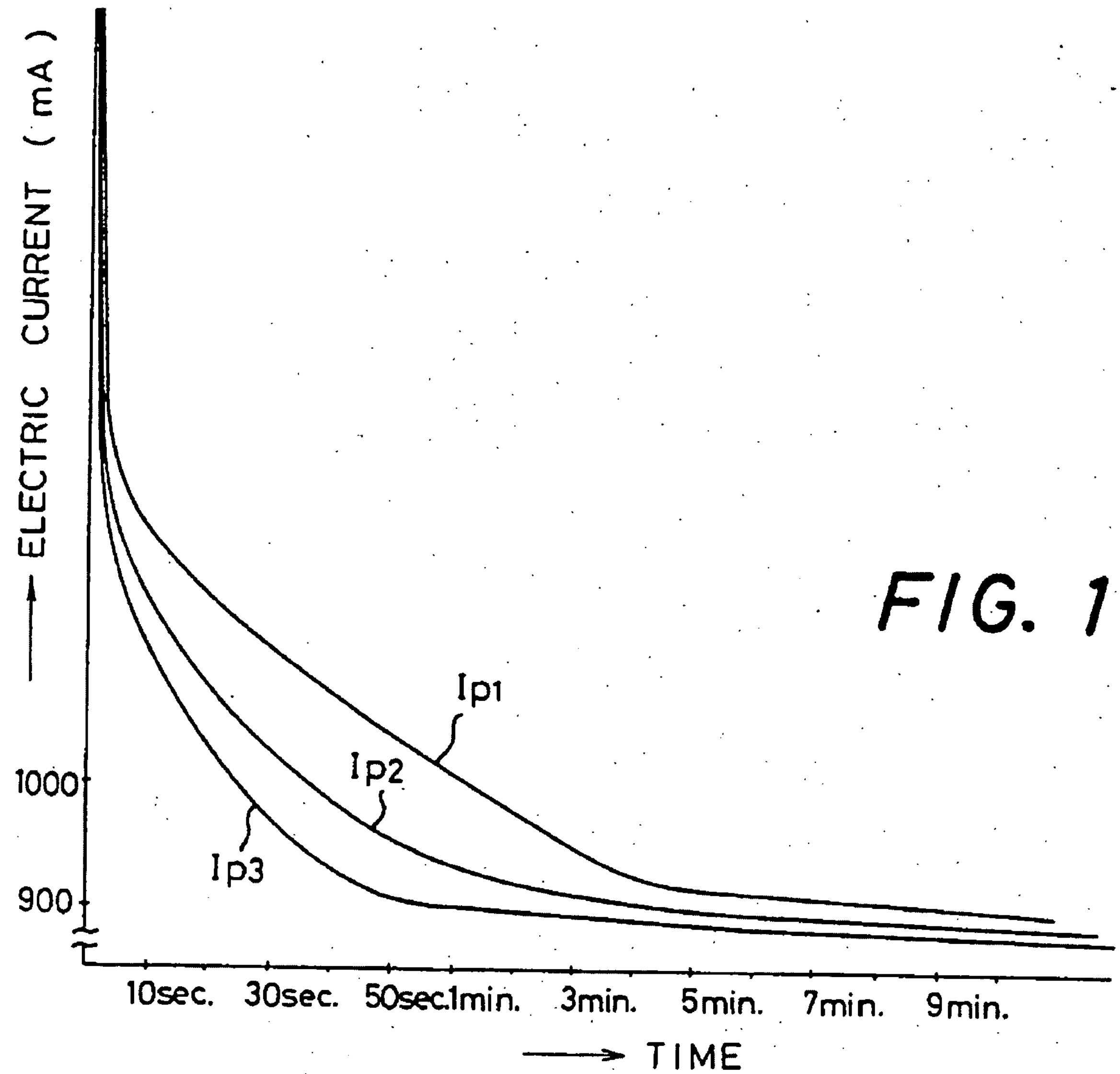

FIG. 1

As shown, electric current does not reduce to zero during the cutting. Thus, contrary to the assertion in the office action, the Aoshima reference does not teach cutting off the current for a predetermined time.

Second, Aoshima teaches that the point at which the "certain predetermined time" is begun is when the threshold has been surpassed, not when the current is below the threshold.

Third, the Aoshima reference teaches an automatic drilling of the motor, whereby the cutter automatically iterates, hitting an upper limit, reducing but not cutting off the current, and then resuming the cutting of the workpiece again. Thus, the Aoshima reference merely teaches an automatic operation and does not relate to a manual operation of the machine.

In contrast, one aspect of the invention as claimed is to cut off the current to the motor for

at least a predetermined time after determining that the load current decreases to be smaller than a reference value. See claim 5 ("subsequently when the first determination unit determines that the load current decreases to be smaller than the first reference value, the control unit turns on the main switching element only after waiting at least a predetermined time after the determination, to supply the current from the power supply to the motor"); see also claim 14 ("subsequently when the determination unit determines a second condition is met, the control unit turns on the main switching element after waiting at least a predetermined time after the determination, to supply the current from the power supply to the motor"). Waiting at least a predetermined amount of time improves operation of the drilling machine for several reasons. First, an operator of the drilling machine may more easily recognize an overload condition of the drill motor by the motor stopping for the relatively long time duration (due to the waiting of at least a predetermined time), and thus can control to weaken his force in an advance direction of a cutter. Second, even if the operator does not recognize the overload condition and continues the operation of the drill, waiting at least a predetermined amount of time before turning on the motor may extend the life of the motor. Specifically, waiting results in a relatively small average amount of a motor current (as opposed to not waiting before re-turning on the motor). It is thus possible to keep the average amount of the motor current within a tolerance range by adjusting the motor stop duration. Breakdown of the motor is less likely to occur, and certainly less likely that the drilling machine taught in the Shoji reference (which does not wait a predetermined amount of time). Therefore, for at least the reasons provided, Claims 5 and 9-15 are patentable over the cited references.

Claims 1, 3, and 4 were rejected under 35 U.S.C. §103(a) as being unpatentable over Gill (U.S. Patent No. 6,280,123) in view of Omi et al. (U.S. Patent No. 5,988,956). Claim 2 was rejected under 35 U.S.C. §103(a) as being unpatentable over Gill in view of Shoji et al. Claims 6 and 7 were rejected under 35 U.S.C. §103(a) as being unpatentable over Shoji et al. in view of Gill.

The Gill reference teaches a drill having an annular cutter (or cutting tool), as shown in Figs. 7-9 thereof. Specifically, Gill teaches that a typical high-speed tool steel annular cutter cannot operate at high speeds. In order to operate at the higher speeds, such as 1200 RPM, Gill teaches that the geometry of the cutting tool must be modified, as discussed in the following:

> Typical cutting tool geometries have been discovered to be unsuitable when

> combined with the drill and feed mechanism of the present invention. Therefore, the cutting tool of the present invention is specially adapted to be used with the compact drill design of the present invention. Specifically, the various cutting angles of previously known tools have been changed and a taper has been added to the cutting portion of the tool as explained in more detail below.

Col. 4, lines 26-34. Thus, Gil teaches tapering is required in order to operate at the higher speeds.

The Omi reference describes a drill which includes an annular cutter having a plurality of carbide tips. However, the Omi reference fails to teach, or even suggest, using the annular cutter at a reduced rotational speed of a drill or an annular cutter that is at least partly tapered.

In contrast, another aspect of the present invention claims an electric drill having "an annular cutter for cutting at a high rotational speed". As acknowledged by the Gill reference, the only manner in which a high-speed tool steel annular cutter may operate at speeds higher than a typical cutter is by modification of the cutter. Specifically, the Gill reference teaches that a high rotational speed on the order of 1200 RPM may only be achieved by a "specially adapted" cutting tool. See col. 4, lines 26-34. Again, as acknowledged by the Gill reference, typical cutting blades of high speed tool steel cannot be operated at such speeds. In order to overcome this limitation of the prior art, the Gill reference teaches a tapering of the annular cutter. See col. 4. lines 26-34.

Applicants note that paragraphs [0049] to [0050] of the present application discuss the limitations of the high-speed tool steel annular cutter. Specifically, the paragraphs reference "How to Select and Use Tools," P.16 (First Edition, published by Kabushiki Kaisha Taiga Shuppan). A copy of excerpts from this reference is enclosed. Also, enclosed is an enlargement of Figure 1 on P. 16 of the reference. Both of the enclosures (which include additional English translations of certain words not found in the original document) show relationships between feed rates (millimeter/revolution) and cutting speeds (meter/minute) of rotational cutters made from various materials, *i.e.*, high speed tool steel, cemented carbide, TiN cermet, TiC cermet, and ceramics. The cutting speed is calculated by multiplying a radius of a rotational cutter by a number of rotations per minute. The feed rate is a rate of feeding of the rotational cutter in its axial direction. In the enlargement of Figure 1, there are shown three curved lines (not found in the original document) each connecting points in the graph which indicate commensurate amounts of materials cut away by rotational cutters. The amount of material cut away is the

product of the feed rate and the cutting speed. As can be seen, line "A" shows that when the cutter of high speed tool steel and the cutter of cemented carbide perform the same work, *i.e.*, cutting away of the same amount of material, the maximum cutting speed at which the cutter of cemented carbide can effect the cutting is about four times the maximum cutting speed at which the cutter of a typical high speed tool steel can effect the cutting. Thus, as shown the enclosure and confirmed by the Gill reference, the cemented carbide tip operates at a much higher drilling speed (which corresponds to rotational speed) than the typical high-speed tool steel cutter.

In contrast, the invention as claimed recites an annular cutter having a main body, with "the main body of the annular cutter being substantially non-tapered". This is in contrast to the modifications taught by the Gill reference to overcome the inherent limitations of using high-speed steel in the prior art. By utilizing the high rotational speed motor adapted to the annular cutter having a non-tapered main body and cemented carbide tips, the cutting resistance can be reduced, as compared with a typical high-speed steel annular cutter that is non-tapered for a rotation at a low speed. This is because, assuming that a torque is constant, the larger a rotational speed is, the smaller cutting force is and hence the smaller cutting resistance is. Due to the smaller resistance force, the sizes and weights of a rotation reduction mechanism and an adhesion base of the drill apparatus can be reduced, which may result in reduction of the size and weight of the whole drill apparatus.

Applicants respectfully disagree that the Omi and Gill references render the claims obvious. The combination of the references would not teach the invention. The Gill reference teaches that the only manner for operating at higher speeds is by tapering as discussed above. Thus, the combination of the references would not teach the high rotational speed limitation of claim 1 with the cutter as claimed. Therefore, the claims are patentable over the cited references.

Summary

Applicants submit that based on the foregoing remarks, the rejections have been traversed, and that the claims are in condition for allowance. Should there be any remaining formalities, the Examiner is invited to contact the undersigned attorneys for the Applicants via telephone if such communication would expedite this application.

Respectfully submitted,

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でか版技能ブックス 11

工具材種の選びかた使い方

超硬合金

HIGH SPEED STEEL

セラミックス

サーメット

CBN

TiC

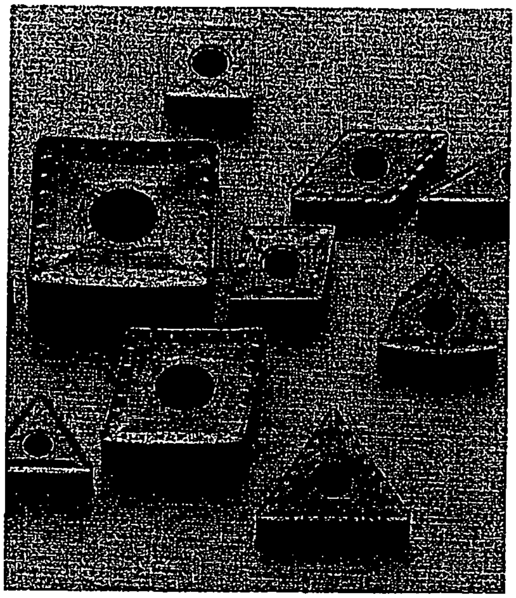
TiN

コーティング

焼結ダイヤモンド

大河 taiga 出版

工具材種のいろいろ



機械加工現場では，加工目的や被削材の種類などに合わせて，いろいろな材種の切削工具が使われています．ここではまず，工具材種にどんなものがあるのか，簡単にみていくことにしましょう．

工具材種には，よく知られているハイスや超硬合金の他に，Al_2O_3（酸化アルミニウム＝アルミナ），またはSi_3N_4（窒化けい素）を主成分とした焼結体の高速切削用セラミックス，TiC（炭化チタン），TiN（窒化チタン）を主成分とした焼結金属のサーメット，あるいは超硬合金表面に，耐摩耗性，耐酸化性をさらに向上させる目的で，TiCやTiN，Al_2O_3などをコーティングした，コーティング超硬合金などがあります．

最近では，C（炭素）やBN（窒化ボロン）などを高温高圧下で焼結した多結晶集積体の焼結体，ダイヤモンド焼結体やCBN焼結体などがあります．

図1は，それぞれの切削特性を切削速度と送りとの関係で表わしたものです．

その選択に誤りがないかどうか，手元の工具材種と使用条件とを確認してください．

1 ハイス（高速度工具鋼）

ハイスは，High Speed Steel（高速度鋼）のアタマだけをとって縮めた，現場での呼びかたが広まったものといわれています．JIS では，高速度工具鋼（英語も High Speed Tool Steel）といっています．

ハイスは，炭素鋼にW（タングステン）18％，Cr（クロム）4％，V（バナジウム）1％を加えたものが基本ですが，これにCo（コバルト）を加えて耐熱性を増したもの，Wの量を減らしてMo（モリブデン）に代えたものなど，いろいろと種類が増えてきました．

現在JISでは，W系としてSKH2，3，4，10の4種が，Mo系としてSKH51，52……58，59の9種，合わせて13種が定められています．

W系は高温かたさが硬いので，バイトに使われています．Mo系はW系に比べて粘りがあるので，穴のなかで折れては困るドリルのように，とくに靱性が要求される工具にはSKH51，また耐摩耗性が必要なホブなどにはCoの多いSKH57などが使われています．

最近では，TiCやTiNなどを被覆して性能を高めたコーティング

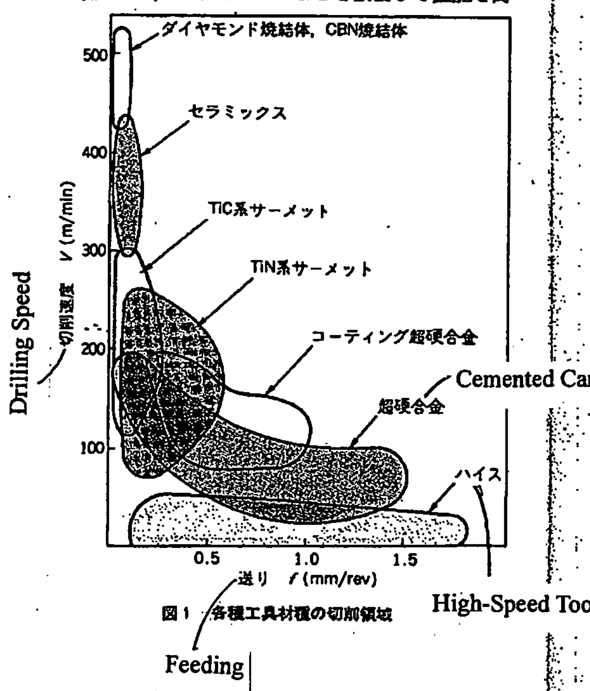


図1 各種工具材種の切削領域

	WC-Ti
	WC-Ti
	WC-C

2 超硬合金

超硬チップは，
として，粉末冶金
しては，その基本
プ材種（工具材種
超硬合金には，
用材種，耐摩耗性
①チップ材種の
用の超硬合金材種
大きく分けていま
硬さに比例した分
に続く数字が小さ
ています．
それぞれの材種
徴と用途を表1に
②チップ材種の
は，P，M，K 種

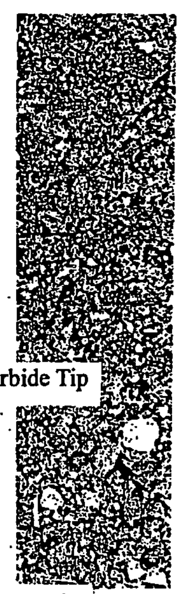
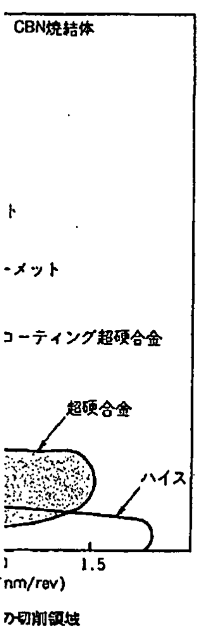


写真1

いろ

代えたものなど，いろろと種類が増えてきました。
現在JISでは，W系とてSKH2，3，4，10の種が，Mo 系としてKH51，52……58，59の種，合わせて13種が定られています。
W系は高温かたさが硬ので，バイトに使われいます。Mo系はW系比べて粘りがあるの，穴のなかで折れてはるドリルのように，とに靭性が要求される工生が必要なホブなどに使われています。
どを被覆して性能を高



の切削領域

表1　超硬P，M，K種の特徴と用途

使用分類	合金成分	合金的特徴	適用被削材
P	WC-TiC-TaC-Co	耐熱性，耐溶着性にすぐれる。TiC，TaCなどを多く含み，とくにクレータや熱亀裂といった熱的損傷に強い	鋼，合金鋼，ステンレス
M	WC-TiC-TaC-Co	TiC，Taなどを適度に含み，熱的，機械的損傷ともに強い	ステンレス，鋳鋼，ダクタイル鋳鉄
K	WC-Co	強度にすぐれるWC主体の合金で，とくにすきとり摩耗のような機械的損傷に強い	鋳鉄，非鉄金属，非金属

めたコーティングハイスが増えています。

2 超硬合金

超硬チップは，WC（炭化タングステン）を主成分として，粉末冶金法でつくられます．切削用工具としては，その基本的な特性を生かして数多くのチップ材種（工具材種）がつくられています．

超硬合金には，切削工具用材種の他に，鉱山土木用材種，耐摩耗性工具用材種などがあります．

①チップ材種の呼びかた……JIS では，切削工具用の超硬合金材種を，P種，M種，K種の3種類に大きく分けています．さらにその分類のなかでも，硬さに比例した分類がされ，P，M，Kの記号の次に続く数字が小さいものほど，硬い超硬材種とされています．

それぞれの材種の成分を図2に，またそれらの特徴と用途を表1に示します．

②チップ材種の選択基準……JIS（JIS B 4035）では，P，M，K 種を作業用途別にまとめて，利用者が選ぶのに迷わないように，使用選択基準をまとめています（巻末データシート参照）．

また，このJIS用途分類に対する各工具メーカーの代表的な推奨超硬材種も，合わせて巻末のデータシートにまとめました．

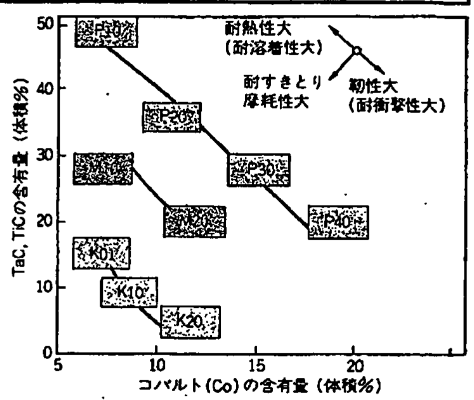


図2　超硬P，M，K種の成分比と特性

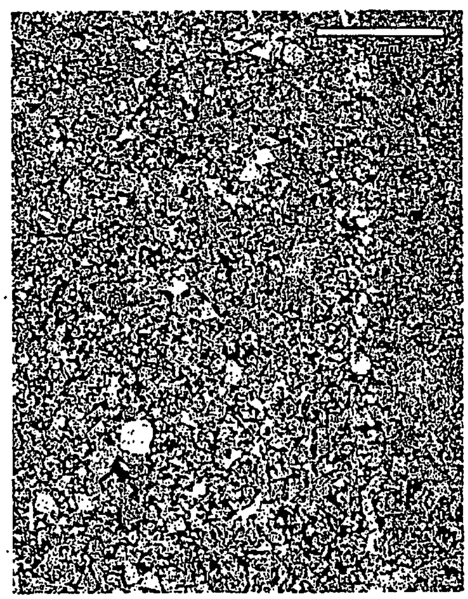


写真1　超微粒子超硬合金のSEM写真


写真2　超硬K20材種のSEM写真

【資料提供】50音順
オーエスジー
京セラ
サンドビック
住友電気工業
ダイジェット工業
東芝タンガロイ
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⑤治具・取付具の作りかた使い方
⑥機械図面の描きかた読み方
⑦研削盤活用マニュアル
⑧NC工作機械活用マニュアル
⑨切削加工のデータブック
⑩穴加工用工具のすべて
⑪工具材種の選びかた使い方
⑫旋削工具のすべて
⑬ツーリングのすべて(刊行予定)

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工具材種の選びかた使い方

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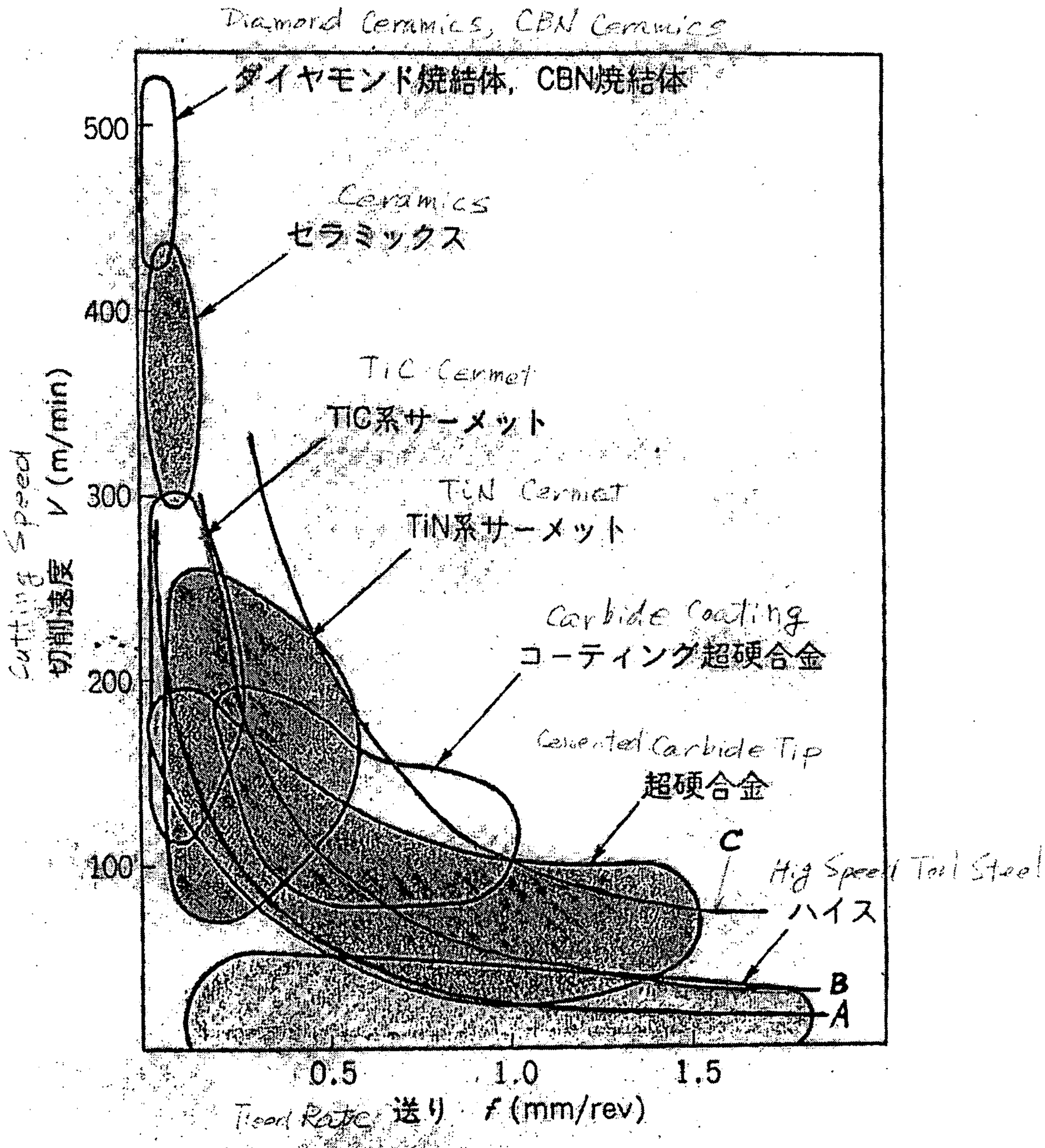

図1　各種工具材種の切削領域

Fig. 1　Suitable Cutting Conditions

from "How to Select and Use Tools"
(First Edition, published by Kabushiki Kaisha
Taiga Shuppan)